

**UNIT TERMINAL OBJECTIVE**

5-1 At the completion of this unit, the paramedic student will be able to integrate pathophysiological principles and assessment findings to formulate a field impression and implement the treatment plan for the patient with respiratory problems.

**COGNITIVE OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 5-1.1 Discuss the epidemiology of pulmonary diseases and conditions. (C-1)
- 5-1.2 Identify and describe the function of the structures located in the upper and lower airway. (C-1)
- 5-1.3 Discuss the physiology of ventilation and respiration. (C-1)
- 5-1.4 Identify common pathological events that affect the pulmonary system. (C-1)
- 5-1.5 Discuss abnormal assessment findings associated with pulmonary diseases and conditions. (C-1)
- 5-1.6 Compare various airway and ventilation techniques used in the management of pulmonary diseases. (C-3)
- 5-1.7 Review the pharmacological preparations that paramedics use for management of respiratory diseases and conditions. (C-1)
- 5-1.8 Review the pharmacological preparations used in managing patients with respiratory diseases that may be prescribed by physicians. (C-1)
- 5-1.9 Review the use of equipment used during the physical examination of patients with complaints associated with respiratory diseases and conditions. (C-1)
- 5-1.10 Identify the epidemiology, anatomy, physiology, pathophysiology, assessment findings, and management for the following respiratory diseases and conditions: (C-1)
  - a. Adult respiratory distress syndrome
  - b. Bronchial asthma
  - c. Chronic bronchitis
  - 4. Emphysema
  - 5. Pneumonia
  - 6. Pulmonary edema
  - 7. Pulmonary thromboembolism
  - 8. Neoplasms of the lung
  - 9. Upper respiratory infections
  - 10. Spontaneous pneumothorax
  - 11. Hyperventilation syndrome

**AFFECTIVE OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 5-1.11 Recognize and value the assessment and treatment of patients with respiratory diseases. (A-2)
- 5-1.12 Indicate appreciation for the critical nature of accurate field impressions of patients with respiratory diseases and conditions. (A-2)

**PSYCHOMOTOR OBJECTIVES**

At the completion of this unit, the paramedic student will be able to:

- 5-1.13 Demonstrate proper use of airway and ventilation devices.  
(P-1)
- 5-1.14 Conduct a history and patient assessment for patients with  
pulmonary diseases and conditions. (P-1)
- 5-1.15 Demonstrate the application of a CPAP/ BiPAP unit. (P-1)

**DECLARATIVE**

I. Introduction

A. Epidemiology

1. Incidence

a) Respiratory complaints are a major aspect of EMS, resulting in 28% of all EMS chief complaints according to a US study of over 2.5 million EMS calls

2. Mortality/ morbidity

a) Over 200,000 persons die from respiratory emergencies each year

3. Risk factors

a) Intrinsic factors which increase the risk of developing respiratory disease

(1) Genetic predisposition

(a) Influences development of

(i) Asthma

(ii) COPD

(iii) Carcinomas

(2) Associated cardiac or circulatory pathologies

(a) Influences development of

(i) Pulmonary edema

(ii) Pulmonary emboli

(3) Stress

(a) Increases the severity of respiratory complaints

(b) May be associated with the frequency of exacerbations of asthma and COPD

b) Extrinsic factors which increase the risk of developing respiratory disease

(1) Smoking

(a) Increases the prevalence of COPD and carcinomas

(b) Increases the severity of virtually all respiratory disorders

(2) Environmental pollutants

(a) Increases the prevalence of COPD

(b) Increases the severity of all obstructive disorders

B. Anatomy and physiology review

1. Global physiology of the pulmonary system

a) Function

- (1) The respiratory system functions as a gas exchange system
  - (2) 10,000 liters of air are filtered, warmed, humidified, and exchanged daily in adults
  - (3) Oxygen is diffused into the bloodstream for use in cellular metabolism by the body's 100 trillion cells
  - (4) Wastes, including carbon dioxide, are excreted from the body via the respiratory system
- b) Physiology
- (1) Ventilation
    - (a) Ventilation refers to the process of air movement in and out of the lungs
    - (b) In order for ventilation to occur, the following functions must be intact
      - (i) Neurologic control (brainstem) needs to initiate inspiration
      - (ii) Nerves between the brainstem and the muscles of respiration (diaphragm & intercostals) need to be intact and undamaged
      - (iii) Diaphragm and intercostal muscles must be functional and non-traumatized
      - (iv) Upper airways must be intact and patent
      - (v) Lower airways must be intact and patent
      - (vi) The alveoli must be intact and non-collapsed
    - (c) Emergent intervention for ventilation problems includes
      - (i) Opening the upper and lower airways
      - (ii) Providing assisted ventilation
  - (2) Diffusion
    - (a) Diffusion refers to the process of gas exchange between the air-filled alveoli and the pulmonary capillary bed
    - (b) Gas exchange is driven by simple diffusion - gases from areas of high concentration to areas of low concentration (gas exchange continues

- until the concentrations are equal)
  - (c) In order for diffusion to occur, the following functions must be intact
    - (i) The alveolar walls must be intact and not thickened
    - (ii) The interstitial space (between the alveoli and capillary wall) must not be enlarged or filled with fluid
    - (iii) The capillary walls must be intact and not thickened
  - (d) Emergent intervention for diffusion problems includes
    - (i) Provision of high flow oxygen
    - (ii) Taking measures to reduce inflammation in the interstitial space
- (3) Perfusion
  - (a) Perfusion refers to the process of circulating blood through the pulmonary capillary bed
  - (b) In order for perfusion to occur, the following functions must be intact
    - (i) There must be adequate blood volume (and adequate hemoglobin within the blood)
    - (ii) The pulmonary capillaries must be intact and not occluded
    - (iii) The left heart must be functioning properly to assure a smooth flow of blood through the pulmonary capillary bed
  - (c) Emergent intervention for perfusion problems includes
    - (i) Ensuring adequate circulating volume and hemoglobin levels
    - (ii) Optimizing left heart function as necessary
- c) Rationale behind learning physiology
  - (1) There are many, many different pulmonary diseases
  - (2) Many diseases act in a variety of different ways on a number of body systems

- (3) Learning the pathophysiology of every respiratory disease is impossible at the paramedic level, and is not a useful exercise because of the dynamic nature of newly developing or identified pulmonary pathologies
  - (4) However, all respiratory problems, old or new, can be categorized as impacting ventilation, diffusion, or perfusion
  - (5) Treatment can be initiated rapidly and effectively once the problem has been identified as ventilation, diffusion, perfusion or a combination
2. Anatomy of the pulmonary system
- a) The upper airway
    - (1) Functions
      - (a) Conduit for air
      - (b) Filtration
      - (c) Warming
      - (d) Humidification
      - (e) Protection of lower airway
    - (2) Structures
      - (a) Nose
      - (b) Pharynx
      - (c) Larynx
  - b) The lower airway
    - (1) Functions
      - (a) Conduit for air
      - (b) Filtration
      - (c) Warming
      - (d) Humidification
      - (e) Removal of foreign particles
    - (2) Structures
      - (a) Trachea
      - (b) Bronchi
      - (c) Bronchioles
      - (d) Cilia
  - c) The gas exchange interface
    - (1) Functions
      - (a) Facilitate gas exchange
      - (b) Transfer gases
      - (c) Mechanism and normals
      - (d) Diffusion

- (e) Venous partial pressures of gases
- (f) Arterial partial pressures of gases
- (g) Oxygen saturation
- (h) Oxyhemoglobin dissociation curve
- (2) Structures
  - (a) Alveoli
  - (b) Interstitial space
  - (c) Pulmonary capillary bed
- d) The chest wall
  - (1) Functions
    - (a) Ventilation
    - (b) Protection of lungs and airways
    - (c) Mechanism and normals
    - (d) The process of inspiration and expiration
    - (e) Normal respiratory volumes (total lung capacity, tidal volume)
  - (2) Structures
    - (a) Diaphragm is the major muscle of respiration
    - (b) Intercostal muscles
    - (c) Accessory muscles
    - (d) Pleural space
- e) The neurologic control of breathing
  - (1) Functions
    - (a) To control ventilation in coordination with physiologic needs
    - (b) Mechanism and normals
    - (c) Driven primarily by the pH of the cerebrospinal fluid - which is influenced by the PaCO<sub>2</sub>
    - (d) Secondary drive is the partial pressure of CO<sub>2</sub> (PaCO<sub>2</sub>)
    - (e) Tertiary drive (typically only utilized in a small number of individuals with severe pulmonary disease) is the PaO<sub>2</sub> as measured by peripheral baroreceptors located in the aortic arch and carotid artery
  - (2) Structures
    - (a) Medulla
    - (b) Phrenic nerve innervate the diaphragm
    - (c) Spinal nerves (thoracic levels)

- innervate the intercostal
- (d) Hering-Breuer reflex prevents overinflation

## II. General system pathophysiology, assessment and management

### A. Pathophysiology

1. A variety of problems can impact the pulmonary system's ability to achieve its goal of gas exchange to provide for cellular needs and excretion of wastes
2. Understanding these problems globally can enable the paramedic to quickly and effectively pinpoint probable causes and necessary interventions
3. Specific pathophysiologies
  - a) Ventilation
    - (1) Upper airway obstruction
      - (a) Trauma
      - (b) Epiglottitis
      - (c) Foreign body obstruction
      - (d) Inflammation of the tonsils
    - (2) Lower airway obstruction
      - (a) Trauma
      - (b) Obstructive lung disease
      - (c) Mucous accumulation
      - (d) Smooth muscle spasm
      - (e) Airway edema
    - (3) Chest wall impairment
      - (a) Trauma
      - (b) Hemothorax
      - (c) Pneumothorax
      - (d) Empyema
      - (e) Pleural inflammation
      - (f) Neuromuscular diseases (such as multiple sclerosis or muscular dystrophy)
    - (4) Problems in neurologic control
      - (a) Brainstem malfunction
        - (i) CNS depressant drugs
        - (ii) CVA or other medical neurologic condition
        - (iii) Trauma
      - (b) Phrenic/ spinal nerve dysfunction
        - (i) Trauma
        - (ii) Neuromuscular diseases

- b) Diffusion
    - (1) Inadequate oxygen concentration in ambient air
    - (2) Alveolar pathology
      - (a) Asbestosis, other environmental lung diseases
      - (b) Blebs/ bullae associated with chronic obstructive lung disease
      - (c) Inhalation injuries
    - (3) Interstitial space pathology
      - (a) Pulmonary edema
        - (i) High pressure (also known as cardiogenic)
          - (a) Left heart failure
          - (b) Idiopathic pulmonary hypertension
        - (ii) High permeability (also known as non-cardiogenic)
          - (a) ARDS
          - (b) Asbestosis, environmental lung diseases
          - (c) Near-drowning
          - (d) Post-hypoxia
          - (e) Inhalation injuries
      - (4) Capillary bed pathology
        - (a) Severe atherosclerosis
  - c) Perfusion
    - (1) Inadequate blood volume/ hemoglobin levels
      - (a) Hypovolemia
      - (b) Anemia
    - (2) Impaired circulatory blood flow
      - (a) Pulmonary embolus
    - (3) Capillary wall pathology
      - (a) Trauma
- B. Assessment findings
- 1. Scene size-up
    - a) Pulmonary complaints may be associated with exposure to a wide variety of toxins, including carbon monoxide, toxic products of combustion, or environments which have deficient ambient oxygen (such as silos, enclosed storage spaces etc.)
    - b) It is critical to assure a safe environment for all EMS personnel before initiating patient

- c) contact
- c) If necessary, individuals with specialized training and equipment should be utilized to remove the patient from a hazardous environment
- 2. Initial assessment
  - a) A major focus of the initial assessment is the recognition of life-threat; there are a variety of pulmonary conditions which may offer a very real risk for patient death
  - b) Recognition of life threat and the initiation of resuscitation takes priority over detailed assessment
  - c) Signs of life-threatening respiratory distress in adults, listed from most ominous to least severe
    - (1) Alterations in mental status
    - (2) Severe cyanosis
    - (3) Absent breath sounds
    - (4) Audible stridor
    - (5) 1-2 word dyspnea
    - (6) Tachycardia > 130 beats/ minute
    - (7) Pallor and diaphoresis
    - (8) The presence of retractions/ use of the accessory muscles
- 3. Focused history and physical examination
  - a) Chief complaint
    - (1) Dyspnea
    - (2) Chest pain
    - (3) Cough
      - (a) Productive
      - (b) Non-productive
      - (c) Hemoptysis
    - (4) Wheezing
    - (5) Signs of infection
      - (a) Fever/ chills
      - (b) Increased sputum production
  - b) History
    - (1) Previous experiences with similar/ identical symptoms
      - (a) The patient's subjective description of acuity is an accurate indicator of the acuity of this episode if the pathology is chronic
      - (b) Asking the patient "what happened the

- last time you had an attack this bad" is an extremely useful predictor of this episode's course
- (2) Known pulmonary diagnosis
    - (a) If the diagnosis is not known to the paramedic, an effort should be made to learn whether it is primarily related to ventilation, diffusion, perfusion, or a combination
  - (3) History of previous intubation is an accurate indicator of severe pulmonary disease, and suggests that intubation may be required again
  - (4) Medication history
    - (a) Current medications
    - (b) Medication allergies
    - (c) Pulmonary medications
      - (i) Sympathomimetic
        - (a) Inhaled
        - (b) Oral
        - (c) Parenteral
      - (ii) Corticosteroid
        - (a) Inhaled
        - (b) Oral (daily versus during exacerbations only)
      - (iii) Chromolyn sodium
      - (iv) Methylxanthines (theophyllin preparations)
      - (v) Antibiotics
    - (d) Cardiac-related drugs
  - (5) History of the present episode
  - (6) Exposure/ smoking history
- c) Physical exam
- (1) General impression
    - (a) Position
      - (i) Sitting
      - (ii) "Tripod" position
      - (iii) Feet dangling
    - (b) Mentation
      - (i) Confusion is a sign of hypoxemia or hypercarbia
      - (ii) Restlessness and irritability may be signs of fear and hypoxemia

- (iii) Severe lethargy or coma is a sign of hypercarbia
  - (c) Ability to speak
    - (i) 1-2 word dyspnea versus ability to speak freely
    - (ii) Rapid, rambling speech as a sign of anxiety and fear
  - (d) Respiratory effort
    - (i) Hard work indicates obstruction
    - (ii) Retractions
    - (iii) Use of accessory muscles
  - (e) Color
    - (i) Pallor
    - (ii) Diaphoresis
    - (iii) Cyanosis
      - (a) Central
      - (b) Peripheral
- (2) Vital signs
- (a) Pulse
    - (i) Tachycardia is a sign of hypoxemia and the use of sympathomimetic medications
    - (ii) In the face of a pulmonary etiology, bradycardia is an ominous sign of severe hypoxemia and imminent cardiac arrest
  - (b) Blood pressure
    - (i) Hypertension may be associated with sympathomimetic medication use
  - (c) Respiratory rate
    - (i) The respiratory rate is not a very accurate indicator of respiratory status unless it is very slow
    - (ii) Trends are essential in evaluating the chronic patient
      - (a) Slowing rate in the face of an unimproved condition suggests exhaustion and impending respiratory insufficiency
  - (d) Respiratory patterns
    - (i) Eupnea
    - (ii) Tachypnea
    - (iii) Cheyne-Stokes

- (iv) Central neurogenic hyperventilation
- (v) Kussmaul
- (vi) Ataxic (Biot's)
- (vii) Apneustic
- (viii) Apnea
- (3) Head/ neck
  - (a) Pursed lip breathing
  - (b) Use of accessory muscles
  - (c) Sputum
    - (i) Increasing amounts suggests infection
    - (ii) Thick, green or brown sputum suggests infection and/ or pneumonia
    - (iii) Yellow or pale gray sputum may be related to allergic or inflammatory etiologies
    - (iv) Frank hemoptysis often accompanies severe tuberculosis or carcinomas
    - (v) Pink, frothy sputum is associated with severe, late stages of pulmonary edema
  - (d) Jugular venous distention may accompany right sided heart failure, which may be caused by severe pulmonary obstruction
- (4) Chest
  - (a) Signs of trauma
  - (b) Barrel chest demonstrates the presence of long-standing chronic obstructive lung disease
  - (c) Retractions
  - (d) Symmetry
  - (e) Breath sounds
    - (i) Normal
      - (a) Bronchial
      - (b) Bronchovesicular
      - (c) Vesicular
    - (ii) Abnormals
      - (a) Stridor
      - (b) Wheezing
      - (c) Ronchi (low wheezes)
      - (d) Rales (crackles)
      - (e) Pleural friction rub

- (5) Extremities
  - (a) Peripheral cyanosis
  - (b) Clubbing is indicative of long-standing chronic hypoxemia
  - (c) Carpopedal spasm may be associated with hypocapnia resulting from periods of rapid, deep respiration
- d) Diagnostic testing
  - (1) Pulse oximetry
    - (a) Used to evaluate or confirm the adequacy of oxygen saturation
    - (b) May be inaccurate in the presence of conditions which abnormally bind hemoglobin, including carbon monoxide poisoning or methemoglobinemia
  - (2) Peak flow
    - (a) Provides a baseline assessment of airflow for patients with obstructive lung disease
  - (3) Capnometry
    - (a) Provides ongoing assessment of endotracheal tube position. End-tidal CO<sub>2</sub> drops immediately when the tube is displaced from the trachea
    - (b) Quantitative versus qualitative
- C. Management
  - 1. Airway and ventilation
    - a) Head-tilt/ chin-lift
    - b) Jaw thrust without head-tilt
    - c) Head-tilt/ jaw thrust
    - d) Oropharyngeal airway
    - e) Nasopharyngeal airway
    - f) Nasal cannula
    - g) Simple oxygen mask
    - h) Nonrebreather mask
    - i) Pharyngeal tracheal double-lumen airway
    - j) Pharyngeal tracheal lumen airway
    - k) Bag-valve-mask
    - l) Bag-valve-mask with PEEP
    - m) CPAP
    - n) Orotracheal intubation
    - o) Nasotracheal intubation
    - p) Suctioning

- q) Endotracheal tube
- r) Oxygen powered manually triggered ventilators
- s) Automatic transport ventilator
- t) Needle cricothyroidotomy
- u) Surgical cricothyroidotomy
- 2. Circulation
- 3. Pharmacological
  - a) Oxygen
  - b) Sympathomimetic
  - c) Albuterol
  - d) Epinephrine
  - e) Isoetharine
  - f) Metaproterenol sulfate
  - g) Racemic epinephrine
  - h) Terbutaline sulfate
  - i) Corticosteroid
  - j) Methylxanthines
  - k) Theophylline ethylenediamine - aminophylline
  - l) Antibiotics
  - m) Mucokinetic drugs
  - n) Mucolytic drugs
  - o) Bronchomucotropic drugs
  - p) Prophylactic asthma drugs
  - q) Cough suppressants - antitussive agents
  - r) "Street" drugs
- 4. Non-pharmacological
  - a) Positioning - sitting up
  - b) Back blows
- 5. Monitoring and devices used in pulmonary care
  - a) Pulse oximetry
  - b) Peak flow
  - c) Capnometry
- 6. Transport considerations
  - a) Appropriate mode
  - b) Appropriate facility

### III. Specific illness

- A. Acute/ adult respiratory distress syndrome
  - 1. Respiratory syndrome characterized by respiratory insufficiency and hypoxia
    - a) Triggers
      - (1) Aspiration
      - (2) Cardio-pulmonary bypass surgery
      - (3) Gram-negative sepsis
      - (4) Multiple blood transfusions

- (5) Oxygen toxicity
  - (6) Trauma
  - (7) Pneumonia
  - (8) Respiratory Infection
2. Findings
- a) Shortness of breath
  - b) Rapid breathing
  - c) Inadequate oxygenation
  - d) Decreased lung compliance
3. Interventions
- a) Airway management
  - b) Oxygen administration
    - (1) Mechanical ventilation
    - (2) PEEP
  - c) Improving underlying condition
  - d) Removing the cause
  - e) Suction prn
- B. Obstructive airway diseases
- 1. A spectrum of diseases which affect a substantial number of individuals worldwide
  - 2. Diseases include asthma and COPD (which includes emphysema and chronic bronchitis)
  - 3. Epidemiology
    - a) Morbidity/ mortality
      - (1) Overall
      - (2) Asthma - 4-5% of US population
      - (3) 20% of adult males have chronic bronchitis
    - b) Causative factors
      - (1) Cigarette smoking
      - (2) Exposure to environmental toxins
      - (3) Genetic predisposition
    - c) Factors which may exacerbate underlying conditions
      - (1) Intrinsic
        - (a) Stress is a significant exacerbating factor, particularly in adults
        - (b) Upper respiratory infection
        - (c) Exercise
      - (2) Extrinsic
        - (a) Tobacco smoke
        - (b) Allergens (including foods, animal danders, dusts, molds, pollens)
        - (c) Drugs
        - (d) Occupational hazards
    - d) Prevention strategies
      - (1) Smoking prevention, particularly for youth
      - (2) Stop smoking for existing smokers
      - (3) Control of air pollution
      - (4) Provision of smoke-free workplaces and public locations
  - 4. Anatomy and physiology review
    - a) Ventilation disorders
    - b) Obstruction occurs in the bronchioles, and may be the result of

- (1) Smooth muscle spasm
    - (a) Beta receptors
  - (2) Mucous
    - (a) Goblet cells
    - (b) Cilia
  - (3) Inflammation
  - c) Obstruction may be reversible or irreversible
  - d) Obstruction causes air trapping through the following mechanism
    - (1) Bronchioles dilate naturally on inspiration
    - (2) Dilation enables air to enter the alveoli despite the presence of obstruction
    - (3) Bronchioles naturally constrict on expiration
    - (4) Air becomes trapped distal to obstruction on exhalation
5. Pathophysiology varies slightly by disease
- a) Asthma
    - (1) Reversible obstruction
    - (2) Obstruction caused by a combination of smooth muscle spasm, mucous, and edema
    - (3) Exacerbating factors tend to be extrinsic in children, intrinsic in adults
    - (4) Status asthmaticus - prolonged exacerbation which doesn't respond to therapy
  - b) Chronic bronchitis
    - (1) Reversible and irreversible obstruction
    - (2) Characterized by hyperplasia and hypertrophy of mucous-producing glands
    - (3) Clinical definition - productive cough for at least 3 months per year for 2 or more consecutive years
    - (4) Typically associated with cigarette smoking, but may also occur in non-smokers
  - c) Emphysema
    - (1) Irreversible airway obstruction
    - (2) Diffusion defect also exists because of the presence of blebs
    - (3) Because blebs have extremely thin walls, they are prone to collapse
    - (4) To prevent collapse, the patient often exhales through pursed lips, effectively maintaining a positive airway pressure
    - (5) Almost always associated with cigarette smoking or significant exposure to environmental toxins
6. Assessment findings
- a) Signs of severe respiratory impairment
    - (1) Altered mentation
    - (2) 1-2 word dyspnea
    - (3) Absent breath sounds
  - b) Chief complaint
    - (1) Dyspnea
    - (2) Cough
    - (3) Nocturnal awakening with dyspnea and wheezing
  - c) History
    - (1) Personal or family history of asthma and/ or allergies
    - (2) History of acute exposure to pulmonary irritant

- (3) History of prior similar episodes
    - d) Physical findings
      - (1) Wheezing may be present in ALL types of obstructive lung disease
      - (2) Retractions and/ or use of accessory muscles
    - e) Diagnostic testing
      - (1) Pulse oximeter to document degree of hypoxemia and response to therapy
      - (2) Peak flow to establish baseline airflow
  - 7. Management
    - a) Airway and ventilation
      - (1) Intubation as required
      - (2) Assisted ventilation may be necessary
      - (3) High flow oxygen
    - b) Circulation
      - (1) Intravenous therapy may be necessary to
        - (a) Improve hydration
        - (b) Thin and loosen mucous
      - (2) Pharmacologic
        - (a) Adrenergic stimulants
        - (b) Albuterol
        - (c) Metaproterenol
        - (d) Terbutaline
        - (e) Atropine sulfate
        - (f) Magnesium
        - (g) Methylxanthines
        - (h) Corticosteroid
    - c) Supportive care
    - d) Transport considerations
      - (1) Appropriate mode
      - (2) Appropriate facility
      - (3) Continue monitoring
      - (4) Contact medical direction
    - e) Psychological support/ communication strategies
- C. Pneumonia
  - 1. Epidemiology
    - a) Incidence
      - (1) Fifth leading cause of death in the US
      - (2) Not a single disease, but a group of specific infections
    - b) Risk factors
      - (1) Cigarette smoking
      - (2) Alcoholism
      - (3) Exposure to cold
      - (4) Extremes of age (old or young)
    - c) Anatomy and physiology review
      - (1) Cilia
      - (2) Causes and process of mucous production
  - 2. Pathophysiology
    - a) Ventilation disorder
    - b) Infection of lung parenchyma

- (1) Most commonly bacterial
- (2) May also be viral or fungal
- c) May cause alveolar collapse (atelectasis)
- d) Localized inflammation/ infection may become systemic, leading to sepsis and septic shock
- e) Community acquired versus hospital acquired
- 3. Assessment findings
  - a) Typical pneumonia
    - (1) Acute onset of fever and chills
    - (2) Cough productive of purulent sputum
    - (3) Pleuritic chest pain (in some cases)
    - (4) Pulmonary consolidation on auscultation
    - (5) Location of bronchial breath sounds
    - (6) Rales
    - (7) Egophony
  - b) Atypical pneumonia
    - (1) Non-productive cough
    - (2) Extra-pulmonary symptoms
    - (3) Headache
    - (4) Myalgias
    - (5) Fatigue
    - (6) Sore throat
    - (7) Nausea, vomiting, diarrhea
    - (8) Fever and chills
- 4. Management
  - a) Airway and ventilation
    - (1) Intubation may be required
    - (2) Assisted ventilation as necessary
    - (3) High flow oxygen
  - b) Circulation
    - (1) Intravenous access
    - (2) Administration of IV fluids
    - (3) Improve hydration
    - (4) Thin and mobilize mucous
  - c) Pharmacological
    - (1) Bronchodilators may be required if airway obstruction is severe or if the patient has accompanying obstructive lung disease
    - (2) Antibiotic therapy by prescription
    - (3) Antipyretics
  - d) Non-pharmacological
    - (1) Cool if high fever
  - e) Transport considerations
    - (1) Elderly, over 65 years
      - (a) Significant co-morbidity
      - (b) Inability to take oral medications
      - (c) Support complications
      - (d) Appropriate facility
  - f) Psychological support/ communication strategies
- D. Pulmonary edema

1. Not a disease but a pathophysiological condition
  - a) High pressure (cardiogenic)
  - b) High permeability (non-cardiogenic)
2. Epidemiology
  - a) Risk factors vary based on type
    - (1) High pressure (cardiogenic)
      - (a) Acute myocardial infarction
      - (b) Chronic hypertension
      - (c) Myocarditis
    - (2) High permeability (non-cardiogenic)
      - (a) Acute hypoxemia
      - (b) Near-drowning
      - (c) Post-cardiac arrest
      - (d) Post shock
      - (e) High altitude exposure
      - (f) Inhalation of pulmonary irritants
      - (g) Adult respiratory distress syndrome (ARDS)
3. Anatomy and physiology review
  - a) Alveoli
  - b) Pulmonary capillaries
  - c) Interstitial space and fluid
  - d) Pulmonary circulation
  - e) Role of surfactant
  - f) Hydrostatic pressure
  - g) Colloid osmotic pressure
  - h) Capillary wall damage
  - i) Left sided heart failure
  - j) Lymphatic drainage
  - k) Pulmonary blood pressures
  - l) Starling's law of the heart
  - m) Hypoalbuminemic states (liver disease)
4. Pathophysiology
  - a) Diffusion disorder
  - b) High pressure (cardiogenic)
    - (1) Left sided heart failure
    - (2) Increase in pulmonary venous pressure
    - (3) Increase in hydrostatic pressure
    - (4) Engorgement of pulmonary vasculature
    - (5) Failure of cough and lymphatics to drain fluids
    - (6) Excessive accumulation of fluid in the interstitial space
    - (7) Widening interstitial space impairs diffusion
    - (8) In severe cases, fluid may accumulate in the alveoli
  - c) High permeability (non-cardiogenic)
    - (1) Disruption of the alveolar-capillary membranes caused by
      - (a) Severe hypotension
      - (b) Severe hypoxemia (post-drowning, post-cardiac arrest, severe seizure, prolonged hypoventilation)
      - (c) High altitude
      - (d) Environmental toxins

- (e) Septic shock
    - (2) Disrupted membranes leak fluid into the interstitial space
    - (3) Widened interstitial space impairs diffusion
  - 5. Assessment findings
    - a) High pressure (cardiogenic)
      - (1) Refer to cardiology unit
    - b) High permeability (non-cardiogenic)
      - (1) History of associated factors
        - (a) Hypoxic episode
        - (b) Shock (hypovolemic, septic, or neurogenic)
        - (c) Chest trauma
        - (d) Recent acute inhalation of toxic gases or particles
        - (e) Recent ascent to high altitude without climatizing
      - (2) Dyspnea
      - (3) Orthopnea
      - (4) Fatigue
      - (5) Reduced exercise capacity
      - (6) Pulmonary rales, particularly in severe cases
    - c) Diagnostic testing
      - (1) Pulse oximetry
  - 6. Management
    - a) High pressure (cardiogenic)
      - (1) Refer to cardiology unit
    - b) High permeability (non-cardiogenic)
      - (1) Airway and ventilation
      - (2) Intubation as necessary
        - (a) Assisted ventilation may be required
        - (b) High flow oxygen
    - c) Circulation
      - (1) Avoid fluid excess
      - (2) Monitor IV flow rates carefully
    - d) Pharmacological
      - (1) Diuretics may be considered in severe cases, but are not usually appropriate since the etiology is NOT high pressure in the pulmonary capillary bed
      - (2) Corticosteroid to stabilize pulmonary capillary and alveolar walls
    - e) Non-pharmacological
      - (1) Position the patient in an upright position with legs dangling
      - (2) Rapid removal from any environmental toxins
      - (3) Rapid descent in altitude if high altitude pulmonary edema (HAPE) is suspected
    - f) Transport decisions
      - (1) Appropriate mode
      - (2) Appropriate facility
    - g) Psychological support/ communication strategies
- E. Pulmonary thromboembolism
  - 1. Epidemiology
    - a) Incidence
      - (1) Responsible for 50,000 death annually

- (2) 5% of sudden deaths
  - b) Mortality/ morbidity
    - (1) Less than 10% of pulmonary emboli result in death
  - c) Risk factors
    - (1) Recent surgery
    - (2) Pregnancy
    - (3) Oral contraceptives
    - (4) Infection
    - (5) Cancer
    - (6) Sickle cell anemia
    - (7) Long bone fractures
    - (8) Prolonged inactivity
    - (9) Bedridden patients
  - d) Prevention strategies
2. Anatomy and physiology review
- a) Deep veins in lower legs
  - b) Venous system
  - c) Coagulation of blood
  - d) Role of venous stasis
  - e) Venous wall injury
  - f) Venous valves
  - g) Pulmonary vasculature
  - h) Ventilation-perfusion mismatch
3. Pathophysiology
- a) Perfusion disorder
  - b) Deep vein stasis
  - c) Injury to vein wall
  - d) Hypercoagulability
  - e) Platelet aggregation
  - f) Embolism size
  - g) Embolism location in the legs
  - h) Embolism location in the lungs
  - i) Complete loss of perfusion in some area of lungs
  - j) Other causes of pulmonary circulation obstruction
    - (1) Air
    - (2) Fat
    - (3) Foreign objects
    - (4) Venous catheters
    - (5) Amniotic fluid
4. Assessment findings - depend on size of the clot
- a) Evidence of significant life-threatening embolus in a proximal location
    - (1) Altered mentation
    - (2) Severe cyanosis
    - (3) Profound hypotension
    - (4) Cardiac arrest
  - b) Chief complaint
    - (1) Chest pain
    - (2) Dyspnea
    - (3) Cough (typically non-productive)

- c) History
  - (1) Sudden onset
  - (2) Identification of risk factors
- d) Physical findings
  - (1) Normal breath sounds or, in severe cases, rales
  - (2) Pleural friction rub
  - (3) Tachycardia
  - (4) Clinical evidence of thrombophlebitis (found in less than 50%)
  - (5) Tachypnea
  - (6) Hemoptysis (fairly rare)
  - (7) Petechiae on upper thorax and arms
- 5. Management - prevention has major role in management
  - a) Depends on the size of the embolism
  - b) Airway and ventilation
    - (1) Intubation if necessary
    - (2) Positive pressure ventilation if required
    - (3) High flow oxygen
  - c) Circulation
    - (1) CPR if required
    - (2) IV therapy; hydration based on clinical symptoms
  - d) Pharmacological
    - (1) Thrombolytic therapy may be appropriate if the diagnosis of pulmonary embolus is confirmed, however, this is rare - especially in the out-of-hospital setting
  - e) Non-pharmacological therapy
    - (1) Support body systems
    - (2) Most severe cases will be managed as a cardiac arrest of unknown origin
  - f) Transport considerations
    - (1) Rapid transport
    - (2) Appropriate mode
    - (3) Appropriate facility
  - g) Psychological support/ communication strategies
- F. Neoplasms of the lung
  - 1. Epidemiology
    - a) Incidence
      - (1) 150,000 have cancer
      - (2) Typical age between 55 to 65
      - (3) Morbidity/ mortality
        - (a) Most die within one year
        - (b) 20% local lung involvement
        - (c) 25% spread to lymph
        - (d) 55% distant metastatic cancer
    - b) Prevention
      - (1) Prevent starting smoking in youth
      - (2) Smoking cessation in smokers
      - (3) Avoidance of environmental hazards, particularly asbestos
      - (4) Cancer screening programs
  - 2. Anatomy and physiology review
  - 3. Pathophysiology

- a) Significant variety in the cell types, and the growth rates associated with each type
- 4. Assessment findings
  - a) Signs of severe distress
    - (1) Altered mentation
    - (2) 1-2 word dyspnea
    - (3) Severe or uncontrollable hemoptysis
  - b) Chief complaints
    - (1) Cough
    - (2) Hemoptysis
    - (3) Dyspnea
    - (4) Hoarseness or voice change
    - (5) Dysphagia
  - c) History
    - (1) Diagnosed history of cancer
  - d) Physical findings
    - (1) Signs and symptoms vary according to location of the tumor
- 5. Management
  - a) Airway and ventilation
    - (1) Intubation if required
    - (2) Assisted ventilation if necessary
    - (3) Oxygen - flow rate based on symptoms and pulse oximetry
    - (4) Supportive care
  - b) Circulation
    - (1) Many patients with diagnosed lung cancer with have an indwelling catheter in place. Local protocols vary regarding whether this catheter may be used for IV infusion in the field.
    - (2) IV infusion may be required to improve hydration or thin/ mobilize sputum
  - c) Pharmacological
    - (1) Out-of-hospital therapy for lung cancer patients is symptomatic, and may include the following
      - (a) Bronchodilators
      - (b) Corticosteroid
      - (c) Continuation of hospital-initiated antibiotics
  - d) Transport considerations
    - (1) End stage patients may have advance directives or DNR
    - (2) Supportive care
  - e) Psychological support/ communication strategies
    - (1) If diagnosed end stage
      - (a) Death and dying patient
      - (b) Family support
- G. Upper respiratory infection
  - 1. Epidemiology
    - a) Incidence
      - (1) 80 million cases in 1975
    - b) Morbidity/ mortality
      - (1) Rarely life threatening
      - (2) Often exacerbates underlying pulmonary conditions
      - (3) Often become significant infections in patients with suppressed immune

- function (such as HIV)
  - c) Risk factors
    - (1) Avoidance of exposure is nearly impossible because of the prevalence of causative agents
    - (2) Severity increases in patients with underlying pulmonary conditions
  - d) Prevention strategies
    - (1) Handwashing and covering the mouth during sneezing and coughing are essential in preventing spread
- 2. Anatomy and physiology review
  - a) Nasopharynx
  - b) Oropharynx
  - c) Paranasal sinus
  - d) Inner ear
  - e) Middle ear
  - f) Outer ear
  - g) Eustachian tubes
  - h) Epiglottis
  - i) Respiratory epithelium
  - j) Lymphatic system
  - k) Secretory antibody IgA
- 3. Pathophysiology
  - a) A variety of bacteria and virus cause URI
  - b) 20-30% are Group A streptococci
  - c) 50% of pharyngitis have no demonstrated bacterial or viral cause
  - d) Most are self-limiting diseases
- 4. Assessment findings
  - a) Chief complaints
    - (1) Sore throat
    - (2) Fever
    - (3) Chills
    - (4) Headache
  - b) Physical findings
    - (1) Cervical adenopathy
    - (2) Erythematous pharynx
    - (3) Positive throat culture
- 5. Management
  - a) Airway and ventilation
    - (1) Typically no intervention required
    - (2) Oxygen administration may be appropriate in patients with underlying pulmonary conditions (administer based on symptoms and pulse oximetry)
  - b) Pharmacological
    - (1) Out-of-hospital care is symptomatic, and based in part on the presence of underlying pulmonary conditions
    - (2) Interventions which may be appropriate include
      - (a) Bronchodilators
      - (b) Continuation of prescribed antibiotics
      - (c) Corticosteroid
  - c) Non-pharmacological

- d) Transport considerations
    - (1) Appropriate mode
    - (2) Appropriate facility
  - e) Psychological support/ communication strategies
    - (1) Collected throat cultures require family notification of results and follow-up care
- H. Spontaneous pneumothorax
- 1. Epidemiology
    - a) Incidence
      - (1) 18 per 100,000
    - b) Morbidity/ mortality
      - (1) 15-20% partial pneumothorax may be well tolerated
    - c) Risk factors
      - (1) Males
      - (2) Younger age
      - (3) Thin body mass
      - (4) History of COPD (secondary spontaneous pneumothorax)
  - 2. Assessment findings
    - a) Chief complaint
      - (1) Shortness of breath
      - (2) Chest pain
      - (3) Sudden onset
    - b) Physical findings
      - (1) Typically minor
        - (a) Pallor
        - (b) Diaphoresis
        - (c) Tachypnea
      - (2) Severe
        - (a) Altered mentation
        - (b) Cyanosis
        - (c) Tachycardia
        - (d) Decreased breath sounds
        - (e) Local hyperresonance to percussion
        - (f) Subcutaneous emphysema
  - 3. Management
    - a) Airway and ventilation
      - (1) Intubation as required
      - (2) Assisted ventilation if necessary
      - (3) Oxygen - administration levels based on symptoms and pulse oximetry
    - b) Circulation
      - (1) IV initiation if severe symptoms present
    - c) Pharmacological
      - (1) Not typically necessary; treat symptomatically
    - d) Non-pharmacological
      - (1) Position of comfort/ best ventilation
    - e) Transport considerations
      - (1) Appropriate mode
      - (2) Appropriate facility
    - f) Psychological support/ communication strategies

- I. Hyperventilation syndrome
  - 1. Multiple causes
    - a) Hypoxia
    - b) High altitude
    - c) Pulmonary disease
    - d) Pulmonary disorders
    - e) Pneumonia
    - f) Interstitial pneumonitis, fibrosis, edema
    - g) Pulmonary emboli, vascular disease
    - h) Bronchial asthma
    - i) Cardiovascular disorders
    - j) Congestive heart failure
    - k) Hypotension
    - l) Metabolic disorders
    - m) Acidosis
    - n) Hepatic failure
    - o) Neurologic disorders
    - p) Psychogenic or anxiety hypertension
    - q) Central nervous system infection, tumors
    - r) Drug-induced
    - s) Salicylate
    - t) Methylxanthine derivatives
    - u) Beta-adrenergic agonists
    - v) Progesterone
    - w) Fever, sepsis
    - x) Pain
    - y) Pregnancy
  - 2. Assessment findings
    - a) Chief complaint
      - (1) Dyspnea
      - (2) Chest pain
      - (3) Other symptoms based on etiology
      - (4) Carpopedal spasm
    - b) Physical findings
      - (1) Rapid breath with high minute volume
      - (2) Varying depending on cause of syndrome
      - (3) Carpopedal spasms
  - 3. Pathophysiology
    - a) Depends on cause of syndrome
  - 4. Management
    - a) Depends on cause of syndrome, discussed elsewhere
      - (1) Airway and ventilation
        - (a) Oxygen - rate of administration based on symptoms and pulse oximetry
      - (2) If anxiety hyperventilation is confirmed (especially based on patient's prior history) coached ventilation/ rebreathing techniques might be considered
    - b) Circulation
      - (1) Intervention rarely required

- c) Pharmacological
  - (1) Intervention rarely required
- d) Non-pharmacological
  - (1) Intervention rarely required
  - (2) Patients with anxiety hyperventilation will require psychological approaches to calm them
  - (3) Have them mimic your respiratory rate and volume
  - (4) Do not place bag over mouth and nose
- e) Transport considerations
  - (1) Appropriate mode
  - (2) Appropriate facility
- f) Psychological support/ communication strategies
  - (1) Depend on cause of hyperventilation